

Remarks

Claims 23-25, 27-31 and 33-34 are pending. Claims 23, 28-31 and 33 are amended. Claim 34 is cancelled without prejudice or disclaimer. Claims 35-38 are new. Support for the amendment of Claim 23 can be found at page 12, lines 28-29, page 17, lines, 35-36, and page 9, line 35 through page 10, line 6. Support for new Claims 35-38 can be found at page 13, lines 19-35, page 9, lines 8-10, page 12, lines 4-9 and in the Examples.

Claims 23-25, 27-31 and 33-34 are rejected under 35 USC §103(a) as unpatentable over JP '211 in view of Okamura, Shigeta or EP '075. The rejection states that JP '211 teaches an adhesion polyimide film formed from a precursor composition comprising a dianhydride and diamine, but does not teach aminosilane, epoxysilane and titanate compounds. The rejection alleges that one skilled in the art would have been motivated to use these compounds in combination with the polyimide film of JP '211 because Okamura, Shigeta and EP '075 teach that they are "publically known additives" that improve adhesion.

The Applicants respectfully disagree. Claim 23 recites an adhesion-enhanced polyimide film which comprises a polyimide (A) layer and a polyimide (B) layer with a thickness of 0.05 to 1 μm formed by heating a coated layer comprising a heat-resistant surface treatment agent and a polyimide precursor that yields the polyimide (B). Claim 23 also recites that the polyimide (B) is obtained from at least one aromatic diamine selected from the group consisting of 2,3,3',4'-biphenyltetracarboxylic dianhydride and 2,2',3,3'-biphenyltetracarboxylic dianhydride and that the at least one aromatic diamine is selected from the group consisting of p-phenylenediamine and 4,4'-diaminodiphenyl ether.

Claim 23 recites that the heat-resistant surface treatment agent is selected from N-[β -(phenylamino)-ethyl]- γ -aminopropyl-triethoxysilane, N-phenyl- γ -aminopropyl-triethoxysilane, and γ -phenylaminopropyl-triethoxysilane. Claim 23 further recites that the multilayer self-supporting film is obtained by coating an organic solvent solution comprising the heat-resistant surface treatment agent and the polyimide precursor which yields a highly heat-resistant amorphous polyimide (B) onto at least one side of the self-supporting film obtained from a polyimide precursor solution which yields the polyimide (A) core layer, and that the polyimide film is obtained by heating the multilayer self-supporting film at a maximum heating temperature of 370-575°C.

To obtain the adhesion-enhanced polyimide film of Claim 23, it is important a) to use the silane coupling agent with a specific secondary amino group as the heat-resistant surface treatment agent, b) to use the polyamic acid solution comprising a specific acid component and diamine component, c) to coat the solution of the polyimide (B) precursor and specific heat-resistant surface treatment agent mixture onto the surface of the self-supporting film of the polyimide (A) core layer, and d) to heat the coated self-supporting film at a high temperature. Thus, a layer of the solution of the polyimide (B) precursor and specific heat-resistant surface treatment agent mixture is formed onto the surface of the self-supporting film of the polyimide (A) core layer, and a part of the specific heat-resistant surface treatment agent penetrates into the self-supporting film of the polyimide (A) core layer. Thereafter, a reaction between the specific heat-resistant surface treatment agent and the polyimide (A) and (B) precursors is caused by heating, and decomposition or oxidation of the specific heat-resistant surface treatment agent is caused by heating at a higher temperature. The result is a thermally modified substance, such as a decomposed or oxidized substance, of the specific heat-resistant surface treatment agent reacted with the precursor in the vicinity of the coated surface of the polyimide (A) core layer and in the polyimide (B) thin layer. Thus, the modified polyimide (A) core layer surface has excellent adhesion with respect to an adhesive.

It should be noted that use of a secondary amine silane coupling agent with the polyimide precursor in an organic solvent allows production of a solution of the silane coupling agent and polyimide precursor mixture because the silane coupling agent does not react (or hardly reacts) with the carboxyl group or amino group of the polyimide precursor. In sharp contrast, if a silane coupling agent with a primary amino group is added to the polyimide precursor, the primary amine silane coupling agent reacts with the carboxyl group or amino group of the polyimide precursor. A generally used amine-based silane coupling agent is a primary amine such as those disclosed in EP '075, which does not provide the polyimide film as recited in Claim 23 which uses a secondary amine silane coupling agent.

The Applicants respectfully submit that JP '211 does not teach or suggest each of the features of Claims 23-25, 27-31 and 33-38. JP '211 discloses a polyimide film having an improved adhesion obtained by coating or spraying an organic polar solvent solution of a

polyamic acid obtained from 2,3,3',4'-biphenyltetracarboxylic dianhydride and 4,4'-diaminodiphenyl ether to one or both sides of a self-supporting film by casting a dope of an organic polar solvent solution of a polyimide precursor comprising 3,3',4,4'-biphenyltetracarboxylic dianhydride and p-phenylenediamine as the main ingredients which may optionally contain an imidization (imidation) catalyst onto a substrate so that the coated or sprayed solution has a thickness of 0.1-1 μm , and then heating the coated or sprayed film at a maximum temperature of 350-500°C. In JP '211, the polyimide film is used by being laminated via an adhesive onto a metal layer.

Claim 23 differs from JP '211 because JP '211 does not teach or suggest that the heat-resistant surface treatment agent is selected from N-[β -(phenylamino)-ethyl]- γ -aminopropyltriethoxysilane, N-phenyl- γ -aminopropyltriethoxysilane and γ -phenylaminopropyltriethoxysilane or that the polyimide film is formed by coating an organic solvent solution comprising a heat-resistant surface treatment agent and a polyimide precursor which yields a polyimide (B) thin layer and heating the coated film at a maximum heating temperature of 370-575°C.

Okamura does not cure the deficiencies of JP '211. Okamura discloses a laminated body in which a polyimide layer etchable by an alkali is directly laminated onto a metal foil. Okamura discloses a polyimide film comprising a layer (B) with a thickness of 0.5-7 μm and a layer (A). The polyimide resin layer (B) of Okamura comprises a polyimide resin obtained by the reaction of a diamine with a tetracarboxylic dianhydride wherein 50 mol% or more of the tetracarboxylic dianhydride is at least one selected from pyromellitic dianhydride, 3,4,3',4'-benzophenonetetracarboxylic dianhydride, 3,4,3',4'-diphenylsulfonetetracarboxylic dianhydride and tetracarboxylic dianhydrides represented by the general formula (1) and 50 mol% or more of the diamine is at least one selected from 2,4-diaminotoluene, 1,3-bis(3-aminophenoxy)benzene, 4,4'-diamino-2'-methoxybenzanilide and diamines represented by the general formula (2). Moreover, the polyimide film of Okamura comprises a thin layer of polyimide (B) formed by coating an organic solvent solution of a polyimide precursor which yields the polyimide (B) and heating the coated solution at a temperature above 200°C (360°C in the examples). The heating is effected at a temperature above 200°C for the purpose of imidation (imidization).

Okamura does not disclose, teach or suggest that a silane coupling agent is added to the organic solvent solution of the polyimide precursor which yields the polyimide (B) thin layer. Additionally, Okamura discloses a laminate in which a polyimide film is directly laminated onto a metal foil, but does not disclose, teach or suggest a laminate of a polyimide film and an adhesive layer.

Claim 23 is not obvious in view of JP '211 and Okamura because Okamura also does not teach or suggest that the heat-resistant surface treatment agent is selected from N-[β -(phenylamino)-ethyl]- γ -aminopropyl-triethoxysilane, N-phenyl- γ -aminopropyl-triethoxysilane and γ -phenylaminopropyl-triethoxysilane. Okamura also fails to teach or suggest that the polyimide film is formed by coating an organic solvent solution comprising a heat-resistant surface treatment agent and a polyimide precursor which yields a polyimide (B) thin layer and heating the coated film at a maximum heating temperature of 370-575°C.

Shigeta also fails to cure the deficiencies of JP '211. Shigeta discloses a method of producing a substrate for a flexible print wiring board, comprising applying a polyimide-based resin precursor solution directly on an electrically conducting material to form a polyimide-based resin precursor layer and thermally curing the polyimide-based resin precursor layer to produce a flexible print wiring substrate having a polyimide-based resin layer. Shigeta discloses that a solution of a polyimide-based resin precursor (B), which is one out of two types of polyimide-based resin precursors, is applied directly on the electrically conducting material and a solution of another polyimide-based resin precursor (A) is applied on a layer of the polyimide-based resin precursor (B), the polyimide-based resin precursor (A) counterbalancing residual strain generated in a polyimide-based resin formed by the thermal curing of the polyimide-based resin precursor (B).

Thus, Shigeta neither teaches nor suggests the combination of the features of Claim 23 or dependent claims such as the heat-resistant surface treatment agent, or that the film is formed by coating a polyimide (B) layer on the polyimide (A) layer.

Similarly, EP '075 fails to cure the deficiencies of JP '211. EP '075 discloses that an adhesive polyimide film which is curable at low temperature and heat resistant and has a high adhesiveness even if subjected to contact bonding on heating at relatively low temperature that is obtained by reacting an acid component, a diamine component, a silicon diamine component and

a primary aminosilane at 0-150°C and imidizing (imidating) the reaction product at a heating temperature of 60-200°C (page 3, lines 20-27, page 4, line 40 through page 5, line 25, and page 11, lines 45-54). EP '075 discloses, at page 12, lines 2-14, "When the adhesive polyimide film of the present invention is subjected to contact bonding on heating onto a material to be adhered, it is possible to obtain a composite product." The heating temperature at that time is about 100° to 350°C. However, to obtain a sufficient adhesion strength, a heating temperature of 130°C or higher is preferable, a somewhat low heating temperature is preferable to avoid degeneration of the material to be adhered. In the case of the adhesive polyimide film of Claim 23, a heating temperature of 130° to 230°C is particularly preferable. The adhesive polyimide film of Claim 23 has a superior adhesiveness onto copper foil and polyimide films even at a low temperature. Hence, it is broadly applicable not only to electronics-related fields such as adhesion of substrates of printed wiring boards, etc., but also as a bonding film or sheet. Moreover, in the adhesive polyimide film of EP '075, adhesiveness is produced by the silicon components which have not been modified through heating at a low temperature.

Thus, EP'075 neither teaches nor suggests that the heat-resistant surface treatment agent is selected from N-[β -(phenylamino)-ethyl]- γ -aminopropyl-triethoxysilane, N-phenyl- γ -aminopropyl-triethoxysilane and γ -phenylaminopropyl-triethoxysilane. EP '075 also fails to teach or suggest that the polyimide (B) is obtained from at least one aromatic tetracarboxylic dianhydride selected from the group consisting of 2,3,3',4'-biphenyltetracarboxylic dianhydride and 2,2',3,3'-biphenyltetracarboxylic dianhydride and at least one aromatic diamine selected from the group consisting of p-phenylenediamine and 4,4'-diaminodiphenyl ether. EP '075 also fails to teach or suggest that a multilayer self-supporting film is obtained by coating an organic solvent solution comprising the heat-resistant surface treatment agent and the polyimide precursor which yields a highly heat-resistant amorphous polyimide (B) onto at least one side of a self-supporting film obtained from a polyimide precursor solution which yields the polyimide (A) core layer. EP '075 also fails to teach or suggest that the polyimide film is obtained by heating the multilayer self-supporting film at a maximum heating temperature of 370-575°C. Lastly, EP -075 does not teach or suggest that the polyimide film is formed by coating an organic solvent solution comprising a heat-resistant surface treatment agent and a polyimide precursor

which yields a polyimide (B) thin layer and heating the coated film at a maximum heating temperature of 370-575°C.

The Applicants respectfully submit that the foregoing demonstrates that the combination of JP '211 with Okamura, Shigeta, or EP '075 fails to teach or suggest each feature of Claims 23-25, 27-31 and 33-38. For example, none of the publications teach or suggest the specifically recited ethoxysilane compounds recited in Claim 23. Moreover, the Applicants respectfully submit that the rejection is silent as to a motivation or reason to modify JP '211 to incorporate the specific ethoxysilane compounds recited in amended Claim 23. Likewise, the publications do not teach or suggest that the multilayer self-supporting film is obtained by coating an organic solvent solution comprising the heat-resistant surface treatment agent and the polyimide precursor which yields a highly heat-resistant amorphous polyimide (B) onto at least one side of the self-supporting film obtained from a polyimide precursor solution which yields the polyimide (A) core layer, and that the polyimide film is obtained by heating the multilayer self-supporting film at a maximum heating temperature of 370-575°C. Accordingly, the Applicants respectfully submit that Claims 23-25, 27-31 and 33-38 are not obvious. Reconsideration and withdrawal of the rejection under §103(a) are respectfully requested.

In light of the foregoing, the Applicants respectfully submit that the entire application is now in condition for allowance, which is respectfully requested.

Respectfully submitted,



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